



INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(51) International Patent Classification ⁶ : A24D 3/14	A1	(11) International Publication Number: WO 96/10929 (43) International Publication Date: 18 April 1996 (18.04.96)
<p>(21) International Application Number: PCT/IB95/00853</p> <p>(22) International Filing Date: 6 October 1995 (06.10.95)</p> <p>(30) Priority Data: 88544 7 October 1994 (07.10.94) LU</p> <p>(71) Applicant (for all designated States except US): G.L.A.D. S.A. [LU/LU]; 92, boulevard de la Pétrusse, L-2320 Luxembourg (LU).</p> <p>(72) Inventors; and</p> <p>(75) Inventors/Applicants (for US only): GARZIA, Aldo [IT/IT]; Via Rimembranze 2, I-20075 Lodi-Milano (IT). GARZIA, Stefano [IT/IT]; Via Rimembranze 2, I-20075 Lodi-Milano (IT).</p> <p>(74) Agent: WEYLAND, J., J., Pierre; Marks & Clerk, 6, rue Glesener, Boîte postale 1775, L-1017 Luxembourg (LU).</p>		<p>(81) Designated States: AL, AM, AT, AU, BB, BG, BR, BY, CA, CH, CN, CZ, DE, DK, EE, ES, FI, GB, GE, HU, IS, JP, KE, KG, KP, KR, KZ, LK, LR, LT, LU, LV, MD, MG, MN, MW, MX, NO, NZ, PL, PT, RO, RU, SD, SE, SG, SI, SK, TJ, TM, TT, UA, UG, US, UZ, VN. European patent (AT, BE, CH, DE, DK, ES, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, ML, MR, NE, SN, TD, TG), ARIPO patent (KE, MW, SD, SZ, UG).</p> <p>Published With international search report.</p>
<p>(54) Title: CIGARETTE FILTERS AND THE LIKE</p> <p>(57) Abstract</p> <p>A filter for tobacco smoke comprises a free-radical inhibitor, particularly an <i>O</i>-alkylated derivative of 2,4-monofurfurylidene sorbitol, together with an antioxidant to reduce the content of polycyclic aromatic hydrocarbons in the smoke.</p>		

FOR THE PURPOSES OF INFORMATION ONLY

Codes used to identify States party to the PCT on the front pages of pamphlets publishing international applications under the PCT.

AT	Austria	GB	United Kingdom	MR	Mauritania
AU	Australia	GE	Georgia	MW	Malawi
BB	Barbados	GN	Guinea	NE	Niger
BE	Belgium	GR	Greece	NL	Netherlands
BF	Burkina Faso	HU	Hungary	NO	Norway
BG	Bulgaria	IE	Ireland	NZ	New Zealand
BJ	Benin	IT	Italy	PL	Poland
BR	Brazil	JP	Japan	PT	Portugal
BY	Belarus	KE	Kenya	RO	Romania
CA	Canada	KG	Kyrgystan	RU	Russian Federation
CF	Central African Republic	KP	Democratic People's Republic of Korea	SD	Sudan
CG	Congo	KR	Republic of Korea	SE	Sweden
CH	Switzerland	KZ	Kazakhstan	SI	Slovenia
CI	Côte d'Ivoire	LI	Liechtenstein	SK	Slovakia
CM	Cameroon	LK	Sri Lanka	SN	Senegal
CN	China	LU	Luxembourg	TD	Chad
CS	Czechoslovakia	LV	Latvia	TG	Togo
CZ	Czech Republic	MC	Monaco	TJ	Tajikistan
DE	Germany	MD	Republic of Moldova	TT	Trinidad and Tobago
DK	Denmark	MG	Madagascar	UA	Ukraine
ES	Spain	ML	Mali	US	United States of America
FI	Finland	MN	Mongolia	UZ	Uzbekistan
FR	France			VN	Viet Nam
GA	Gabon				

CIGARETTE FILTERS AND THE LIKE

The present invention is concerned with the treatment of filters for tobacco smoke, particularly cigarette filters, to limit the carcinogenic effect of the smoke passed by them to the consumer.

Tobacco smoke, particularly that from cigarettes, is well-known to contain various components which are either carcinogens or pro-carcinogens. One particular class of compounds falling within this category comprises the polycyclic aromatic hydrocarbons (PAH) which are converted by the cytochrome P450 enzyme system in the liver or the lung into oxygenated derivatives which have been shown to be carcinogenic. A considerable amount of literature now exists in this field, for example: Pryor, *et al.* *Science* 220:425-427; Pryor, *et al.* *Cancer and Free-Radicals, in Antimutagenesis and Anticarcinogenesis Mechanisms*; Ed. D Shankel, *et al.*; Plenum Press, New York NY, pages 45-59; Janoff, *et al.* 1987 *Am. Rev. Respir. Dis.* 136:1058-1064 and many others. The effect of free-radicals in the smoke has been extensively discussed, for example by Church and Pryor *Environ. Health. Perspect.* 64:111-126 (1985).

20

GB-A-1044434 discloses the use of 2,4-monofurfurylidene sorbitol in cigarette filters to reduce the content of PAH in the smoke.

In situations where free-radicals are known to cause harm, for example in the skin, the use of free-radical inhibitors is well-known. For example, EP-B-0 345 362 discloses the use of a particular type of free-radical inhibitor in skin cosmetics. The inhibitor in question is chosen from a group of furfurylidene derivatives of sorbitol, in particular 2,4-monofurfurylidene sorbitol and the tetra-*O*-alkyl derivatives thereof. A method for preparing 2,4-monofurfurylidene sorbitol was disclosed in US-A-3,383,279 comprising gradual addition of furfural to acidified sorbitol, thus forming the 2,4-*O*-furfurylidene derivative.

We have now investigated the effect of these sorbitol derivatives in other areas. Surprisingly, we have now found that the furfurylidene sorbitol derivatives of EP-B-0 345 362, in combinations with certain other components, can be used to impregnate tobacco smoke filters to achieve smoke which has a dramatically reduced content of PAH. The mechanism of this action is unknown and unexpected: on the model of previous uses of free-

CONFIRMATION COPY

radical inhibitors. it would be expected that the inhibitor must be present at the site of absorption by the body and not at a remote location. The compounds appear to remove mutagenic or carcinogenic compounds from the smoke, but other explanations are possible.

5

According to the present invention there is thus provided a filter for tobacco smoke comprising means forming a passageway for smoke, characterised in that on a surface of the passageway arranged to contact the smoke there is provided an *O*-alkylated derivative of 2,4-monofurfurylidene sorbitol together with an antioxidant. The *O*-alkylated derivative is desirably a C₁₋₅-alkyl derivative, e.g. the methyl derivative, and the tetra-*O*-alkyl derivative is preferred.

The filter according to the invention is particularly represented by a cigarette filter, which may have any conventional construction arranged to provide a very large surface area in contact with the smoke passing through, for example packed filaments, open-cell foams, etc.

The free-radical inhibitor may be incorporated in the filter at any effective level, but typically at 2.5-30 mg per filter, especially about 5-20 mg, particularly when tetra-*O*-methyl 2,4-monofurfurylidene sorbitol is used.

The filter also contains an antioxidant and the ratio by weight of the sorbitol derivative to the antioxidant is desirably from about 1.5:1 to 3:1, especially, about 2:1. Particularly preferred antioxidants comprise phenolic antioxidants such as *tert*-butyl-hydroxyanisole (BHA) or *tert*-butyl-hydroxytoluene (BHT).

It appears that there is synergy between the sorbitol derivative and the antioxidant, and both components are necessary for maximum activity.

The active components can be added to the cigarette filter by any convenient method, for example by dosing with a solution of the components and allowing the solvent to evaporate. Alternatively, the packing material for the filter can be pre-impregnated with the active component before the filter is constructed.

The following Example illustrates the invention further.

EXAMPLE - Measurement of benzo[α]pyrene and tar levels

In a series of tests, standard cigarettes were used - either Kentucky Reference 1R3F or commercial cigarettes containing no additives in the filter. The following additives were investigated:

2,4-monofurfurylidene sorbitol tetra-*O*-methyl ether (FT)
tert-butyl-hydroxyanisole (BHA)

The results are summarised in the following table. The stated additive, dissolved in 40-60 μ l diethyl ether, was added in six to ten aliquots using a microsyringe to inject through the end of the filter. Control cigarettes were prepared using diethyl ether only. The cigarettes were stored in conditions of controlled humidity and temperature for twenty-four hours and were tested to check that there had been no change in the pressure drop across the filter.

The test methods were standard in the industry for the investigation of cigarette smoking and analysis of tobacco smoke. The cigarettes were "smoked" in a smoking machine conforming to the standard US Federal Trade Commission smoking protocol and the smoke was passed through a Cambridge filter, which was weighed before and after the smoking. The increase in weight of the filter is the total particulate matter (TPM). Nicotine was extracted from the filter by washing with alkaline methanol and estimated using gas chromatography using a nitrogen-phosphorus detection. The water content of the TPM was measured by extracting the filter with ethanol followed by gas chromatography with conductivity detection. Tar is calculated by deducting the nicotine and water contents from the TPM.

Benzo[α]pyrene (BaP) is taken as a representative carcinogen for tobacco smoke and was measured by HPLC analysis (with fluorescence detection) of a cyclohexane extract of the Cambridge filter.

TABLE

		FT (mg/cig)	0	20/30	0	0	20
		BHA (mg/cig)	0	0	10	30	10
5	TPM (mg/cig)	Control	19.8				
		FT (20/30 mg)		19.1			
		BHA (10 mg)			19.6		
		BHA (30 mg)				18.7	
		FT (20 mg) + BHA (10 mg)					15.9
10	Tar (mg/cig)	Control	15.1				
		FT (20/30 mg)		14.4			
		BHA (10 mg)			16.0		
		BHA (30 mg)				14.9	
		FT (20 mg) + BHA (10 mg)					14.0
15	Nicotine (mg/cig)	Control	1.31				
		FT (20/30 mg)		1.34			
		BHA (10 mg)			1.24		
		BHA (30 mg)				1.25	
		FT (20 mg) + BHA (10 mg)					1.06
20	BaP (ng/cig)	Control	14.3				
		FT (20/30 mg)		13.0			
		BHA (10 mg)			13.7		
		BHA (30 mg)				7.9	
		FT (20 mg) + BHA (10 mg)					6.6
25	BaP % Control	Control	100				
		FT (20/30 mg)		91			
		BHA (10 mg)			96		
		BHA (30 mg)				55	
		FT (20 mg) + BHA (10 mg)					46
30							

As can be seen from the last column, for a 2:1 combination of FT and BHA, a highly significant reduction in BaP was noted.

Similar applications in other smoke filters can be envisaged, for example filter cartridges in tobacco pipes. An expert in the art will be

able to foresee several modifications and variations, which will be considered all included within the scope of the present specification.

CLAIMS

1. A filter for tobacco smoke comprising means forming a passageway for smoke, characterised in that on a surface of the passageway arranged to
5 contact the smoke there is provided an *O*-alkylated derivative of 2,4-monofurfurylidene sorbitol together with an antioxidant.
2. A filter according to Claim 1, in which the antioxidant is a phenolic antioxidant.
- 10 3. A filter according to Claim 2, in which the antioxidant comprises *tert*-butyl-hydroxyanisole (BHA) or *tert*-butyl-hydroxytoluene (BHT).
4. A filter according to any of Claims 1 to 3, in which the *O*-alkylated
15 derivative comprises 2,4-monofurfurylidene-1,3,5,6-tetra-*O*-methyl sorbitol.
5. A filter according to any of Claims 1 to 4, in which the ratio by weight of the free-radical inhibitor to the antioxidant is from 1.5:1 to 3:1.
- 20 6. A filter according to Claim 5, in which the ratio is about 2:1.
7. A filter according to any of Claims 1 to 6 in the form of a cigarette filter.
- 25 8. A filter according to Claim 7 containing 2.5 to 30 mg of the free-radical inhibitor.
9. A filter according to Claim 8 containing about 5 to 20 mg of the
30 free-radical inhibitor.

INTERNATIONAL SEARCH REPORT

Patent Application No

PC1/IB 95/00853

A. CLASSIFICATION OF SUBJECT MATTER
IPC 6 A24D3/14

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 6 A24D

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	FR,A,1 533 175 (ISTITUTO CHEMIOTERAPICO ITALIANO) 19 July 1968 see the whole document ---	1-9
A	DATABASE WPI Week 9414 Derwent Publications Ltd., London, GB; AN 94-114240 & JP,A,06 062 824 (KYODO NYUGYO) , 8 March 1994 see abstract ---	1
A	WO,A,94 00138 (VYREX CORPORATION) 6 January 1994 see page 3, line 9 - page 4, line 19 see page 8, line 1 - page 9, line 8; example 2 --- -/--	1

☒ Further documents are listed in the continuation of box C.☒ Patent family members are listed in annex.

* Special categories of cited documents:

- "A" document defining the general state of the art which is not considered to be of particular relevance
- "E" earlier document but published on or after the international filing date
- "L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)
- "O" document referring to an oral disclosure, use, exhibition or other means
- "P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

"&" document member of the same patent family

Date of the actual completion of the international search

4 January 1996

Date of mailing of the international search report

16.01.96

Name and mailing address of the applicant

European Patent Office, P.B. 5818 Patentlaan 2
NL - 2280 HV Rijswijk
Tel. (+31-70) 340-2040, Tx. 31 651 epo nl,
Fax (+31-70) 340-3016

Authorized officer

Lepretre, F

INTERNATIONAL SEARCH REPORT

International Application No

PCI/IB 95/00853

C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	GB,A,2 230 687 (PÉCSI DOHANYGYÁR) 31 October 1990 -----	

Form PCT/ISA/210 (continuation of second sheet) (July 1992)

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
FR-A-1533175	22-11-68	BE-A- 659231 GB-A- 1044434 US-A- 3332427	25-07-67
WO-A-9400138	06-01-94	US-A- 5308874 AU-B- 4253793 CA-A- 2147348 US-A- 5461080	03-05-94 24-01-94 06-01-94 24-10-95
GB-A-2230687	31-10-90	BE-A- 1003263 DE-A- 3940901 FR-A- 2646325 JP-A- 2303475 NL-A- 9000005 SE-A- 8904109 US-A- 5060672	11-02-92 31-10-90 02-11-90 17-12-90 16-11-90 29-10-90 29-10-91

THIS PAGE BLANK (USPTO)